COTTON WORM OR "CATERPILLAR"

By

W.E.Hinds.

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THE COTTON WORM OR CATERPILLAR.

(*Alabama argillacea*, Hubn.)

By W. E. Hinds.

The name "army worm" is also often applied to this species, as it is to several others, among which the "grass worm" or "fall army worm" of the South is the most common. The distinction between these two species should be kept clearly in mind by the reader, as the two species have quite different habits as to the plants upon which they feed, the general manner of their feeding, and in their manner of transformation from the caterpillar to the moth stage. We are here considering only the cotton worm, which feeds upon nothing but cotton and which species has repeatedly done extensive damage to cotton throughout the South during more than a century.

The cotton worm is not a native insect in the United States, as cotton itself is not native here. It comes to us each year that it occurs in the cotton belt from the West Indies and from Central and South America, where cotton grows wild from year to year. The first serious outbreak on record occurred as far back as 1793 in Georgia and South Carolina. Since then cotton worms have been found irregularly, without doubt being dependent upon a certain coincident set of either favorable or unfavorable climatic and food conditions in its winter home as well as here.

During this 119 years there have been seven great caterpillar years, of which 1911 was the last. In Alabama, and perhaps throughout the South, 1873 will be long remembered as marking the climax of a series of three years of increasing damage. Yet in that year but 38 counties in this State reported trouble from worms. In the outbreak of 1911 before the end of the season 66 of the 68 counties in Alabama had been practically stripped by the worms. Careful field studies combined with reports received from all counties indicated that Alabama alone suffered a reduction of between 120,000 and 175,000 bales. This lint, with its seed, would mean at the minimum figure a damage of more than $7,000,000 in this one State. Similar injury occurred in Mississippi, Arkansas, Louisiana, and Texas. The severity of the injury is hidden to a large extent by the record-breaking crop produced in spite of it, and was greatly decreased from what was anticipated because of the unusual proportion of the crop of 1911 that was "made" before the end of July. Very little cotton was added to the crop after that.

In the fight against the worms in 1911 it is certain that more arsenical poison was used than has ever been used elsewhere in anything like the same area and in the same space of time. Powdered arsenate of lead was used for the first time against the cotton worm and easily

proved its many advantages over Paris green for this purpose. During the first season much more of it was used than there was of Paris green. In Alabama and Mississippi alone more than 1,000,000 pounds of these two poisons was distributed, and the value of this item in the making of the 1911 crop was, therefore, all of $250,000. Had the poison been available and planters generally ready and willing to use it promptly and properly a very large part of the loss estimated above for Alabama could have been prevented.

CONDITIONS INDICATING OUTBREAKS.

A study of the history of cotton-worm outbreaks shows that in the years of greatest damage certain conditions have always occurred. Among the most significant of these have been unusually wet seasons, which both favored the development of the worms and retarded that of the crop. Cotton was late, or at least in thrifty, vigorous leaf, and the worms first appeared scatteringly before the middle of August in the Middle Gulf States. A condition of frequent showers and of many cloudy days during August and September has increased the outbreak. The generations or "crops" of worms are completed in between three and four weeks with constantly increasing numbers of the worms and their more general distribution. There are then certain to be three generations of worms before the cotton can be picked out. Whenever these conditions are present we may anticipate a serious outbreak of the worms. It is true that subsequent conditions unfavorable to the worms, such as extremely hot, dry weather, may serve to check the outbreak materially, but they are not likely to prevent material damage.

LIFE HISTORY.

The full life history of the cotton worm may be more easily and closely followed by the average man than can that of almost any other insect. All of its four stages are to be found on the cotton plant, all above ground, and frequently all stages may be present at the same time. Three of these stages do no damage whatever to the plant.

First stage: The egg.—The egg laid by the cotton-worm moth, or "candle fly," is of a pale bluish-green color, gradually becoming more nearly white as it approaches hatching time. It is only about one-fortieth of an inch in diameter, but a very pretty shell-like object, that can be found only by rather careful hunting on the undersides of the larger leaves around the middle third of the cotton plant. They are not at all hard to see when one becomes accustomed to them. They are always placed singly, although several may occur on one leaf. (See Pl. I, fig. 1.) The egg hatches in two or three days during warm weather, as in August, but requires a little longer time later in the season.

Second stage: The cotton worm.—The caterpillar is the only stage that really injures cotton. On hatching from the eggs the worms are pale yellowish-green in color and very inconspicuous. They are found only on the undersides of the leaves on which the eggs were laid. As they grow the markings become more distinct and frequently vary widely, showing an increase in the proportion of black especially. Fully grown cotton worms are very conspicuously

marked, and it would seem that once seen abundantly they might always be remembered. They are rather slender and reach a length of about 1½ inches. The caterpillars of the earlier generations usu-

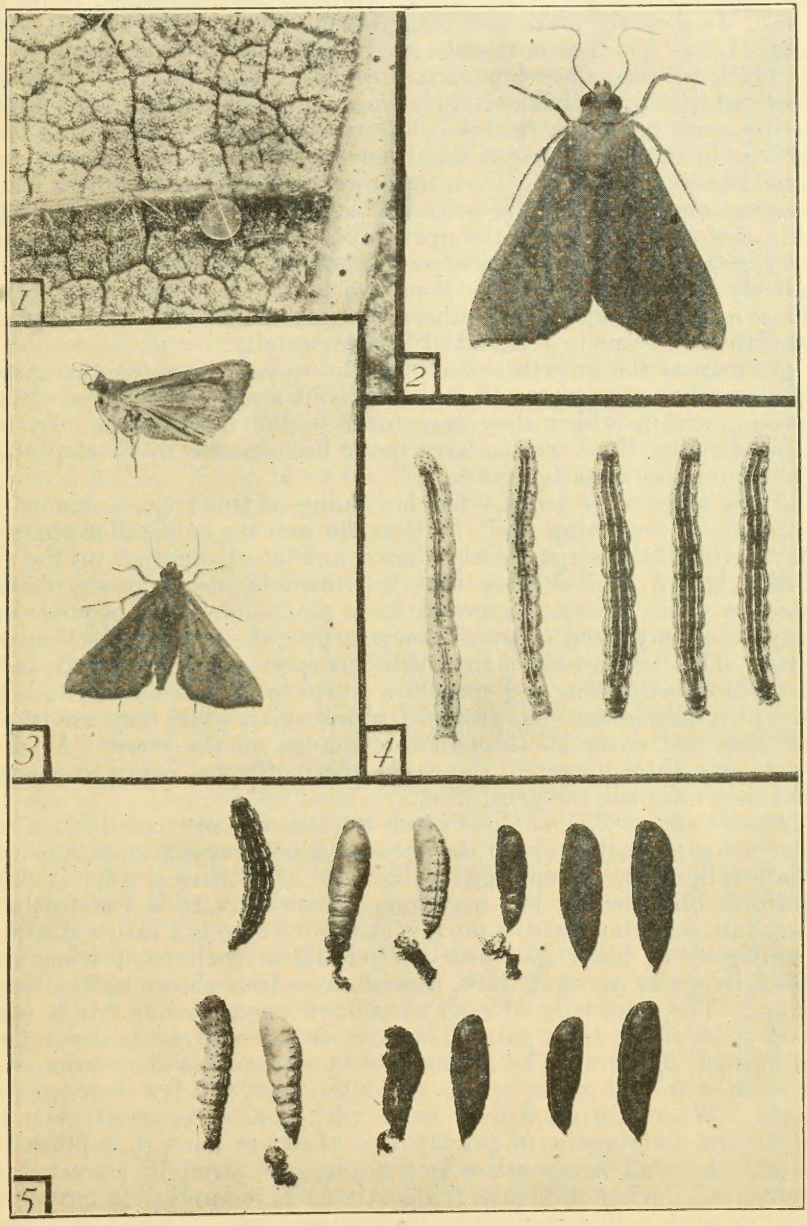

PLATE I.—COTTON WORM STAGES.

Fig. 1, the egg; fig. 2, moth, natural position; fig. 3, moth showing markings on upper and under sides of wings; fig. 4, worms showing variations in color; fig. 5, transformation to pupa. Fig. 1, enlarged x 10; fig. 2, enlarged x 2; others natural size. (Original.)

ally show much less black than do those of a later period near the end of the season. The light forms are quite bright yellowish-green in body color, with three narrow white stripes and two rows of conspicuous black spots, each set with a black spine, arranged along its back. In these the black spot is surrounded by a circle of white color. (Pl. II, fig. 1.) The dark-colored specimens are due to the increase of black between the white stripes and including the rows of black spots which appear in the lighter worms until it forms velvety black stripes with only very narrow white stripes between. The hind pair of legs in the cotton worm stand out very prominently as they rest upon the cotton leaves. When the worms travel they go with a half-looping movement that is quite characteristic of this species. The skin is shed five times in the growth of each worm. The worms are very active, and have a peculiar method of protection by jumping quickly to a distance of a foot or two horizontally when disturbed. They may catch upon some other plant in the next row. This whole growth may occur in from 10 to 15 days usually.

As soon as the growth is complete the worms draw together parts of leaves so as to cover their bodies and spin a very loose silken cocoon, within which they transform to the moth stage. In the United States these worms have never been known to develop completely on any plant but cotton.

Third stage: The pupa.—The beginning of this stage is known to everyone as "webbing up." Within the web the caterpillar changes first through the steps plainly shown in Plate I, figure 5, to the familiar brown conical body that is known by nearly every cotton planter. This always occurs on some plant above the ground, but may be on any weed or grass that can give them the protection desired. This is one respect in which this species differs entirely from the cotton-boll worm and the grass worm or fall army worm, both of which burrow into the ground for protection while they are transforming and never go through this change on the plant. After a week or a little longer in this stage the moths are ready to emerge and they complete the generation.

Fourth stage: The moth.—Cotton-worm moths or "candle flies," as they are often called, are of the size and general appearance shown in Plate I, figure 3, and enlarged in figure 2. The general color is quite uniform olive-brown, but may vary somewhat. It is frequently a dark tan, sometimes with a purplish tinge. There is a rather distinct, small gray or black spot near the middle of each front wing and faint, irregular or wavy dark, reddish cross lines shown on the front wings. The outer edge of each wing has a narrow white fringe with dark spots on the front pair. The position when at rest is shown best in Plate I, figure 2. The moths hide by day among the cotton, and especially around grassy spots. They fly, feed, and lay their eggs at night. When disturbed they move with a peculiar swift, darting flight and hide again so quickly that they are hard to capture by hand. As with many other moths, they are strongly attracted to lights, and during outbreaks frequently make it impossible for one to read or work with a lamp in an unscreened house. These moths feed somewhat on nectar produced by many plants, especially by the leaf glands of cotton, and also upon the juices of fruits, which they can wound with their slender tongue when it is uncoiled. The moth stage

completes the life cycle and the females begin very soon the deposition of eggs for the next generation.

Within a week or 10 days they may deposit from 400 to 600 eggs and then die, but their powers of flight are such that at the time of their death they may be many hundreds of miles from where they hatched out. A remarkable demonstration of their flight occurred in September, 1911, when store fronts and electric-light poles in Cleveland, Ohio, were thickly covered with moths of this species. They were very numerous also in New Jersey, New York, and Massachusetts, and were taken also in Maine and Canada. But in all this northern country there is no food plant for the species and all must perish. The instinct for northward flight has carried them too far.

Hibernation.—What has just been said regarding the flight of these moths will help us to understand better than we otherwise could how it is that we may have cotton worms year after year when it is probably true that very rarely, if ever, does a single moth of this species survive the winter within the limits of the United States, unless in south Florida and Texas. All immature stages die quickly with but little cold. The species appears to pass the winter where cotton also lives through and mainly perhaps in the West Indies and South America. From these far distant regions the moths fly northward with each succeeding generation until they overspread the cotton States and many others where cotton does not occur.

Feeding habits of worms.—For the first few days of their active life the young worms feed only on the underside of the leaf on which they hatch. They do not eat clear through, but leave the thin upper tissue of the leaf uncut—probably partly as a measure of protection. These "skinned spots" quickly turn brown and are quite characteristic of young leaf worm work. They are a good guide to follow when hunting for young worms. After they have shed their first skin, the worms become large and strong enough to eat through the leaves and then usually begin to move toward the more tender foliage at the top of the plant. Up to this time the young worms can hardly be poisoned by any dust method. After they move to the top they become one of the easiest leaf-eating caterpillars to destroy. They prefer the tops of the plants and the thin blade of the leaf, and these are exactly the parts where poison is most easily distributed for their destruction.

The first "ragging" begins only when many worms are about half grown—that is, about 5 to 7 days old. After that the rate of destruction of the leaves depends upon the number of worms at work. It may take a week or only two days to strip a field. In 1911 it was a very common matter to hear men tell of first discovering a few worms "ragging" their cotton on Saturday afternoon and finding early on Monday morning, when they would go out to poison, that there wouldn't be enough leaf left to put poison on. Treatment for cotton worms must therefore be made just as soon as the first signs of their work appear. There may be no time thereafter to send off for poison, even if ordered by telegraph and shipped by express. The only safe way is to be prepared, even before worms appear, with the dusting outfit made and some stock of poison kept on hand. Some illustrations of cotton worm work are shown in Plates II and III. When

pushed for food the worms commonly destroy all squares, small bolls, and even many of those that are fully grown, and gnaw the bark

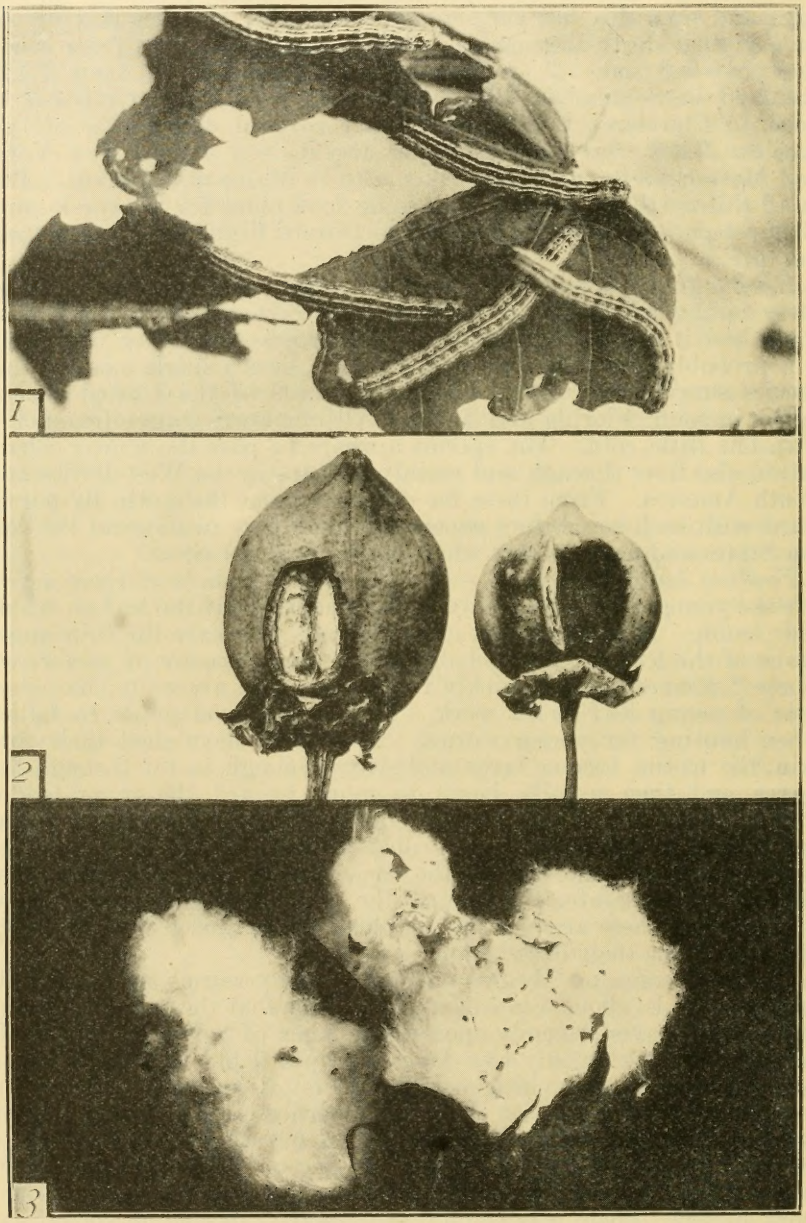

PLATE II.—COTTON WORM WORK.

Fig. 1, worms devouring leaf; fig. 2, bolls eaten into and ruined; fig. 3, lint dirty and stained. All natural size. (Original.)

from the stalk. They may then leave the stripped field in hordes, marching for a fresh food supply; hence the name (improperly applied) "army worm."

Generations.—As shown in the account of its life history, the life cycle is completed in about three weeks. There are therefore really some six or more generations of these worms somewhere on cotton during our usual growing season. It is customary for planters to speak of that generation which does the first noticed "ragging" as being "the first crop," and the succeeding "crops" are numbered accordingly. We usually have three destructive generations in years of severe outbreaks. In Alabama, in 1911, the first stripping occurred toward the latter part of July. In other fields there was more general stripping before the 10th of August. By the middle of the month 58 counties reported worms. Up to this time the damage might be considered local rather than general. From the moths that were very numerous between August 10 and 15, the next generation was expected to and did strip cotton generally during the last 10 days of August, and the next generation appeared about the middle of September. The most favorable and effective time to poison these worms is at the time the first worms of each generation move to the tops and "ragging" begins, provided a poison like arsenate of lead is used that will adhere to the leaves in spite of rains for a sufficiently long time to kill practically all worms in the generation as fast as they become large enough to eat through the leaves. Generations become less clearly defined and the difference in time between the first and last members in each becomes greater with each successive "crop" of worms.

Enemies.—The cotton worm has a number of natural enemies, some of which are quite important as aids in destroying them. Among these are some of the small brown ants, known as "fire ants"; ground beetles, wasps, and predaceous bugs; parasitic flies and wasps upon the eggs, the worms, or the pupæ; birds, etc. All of these help, but even when most effective it is hardly possible for them to prevent the multiplication of the worms to a point where it will not require the application of poison to save the cotton.

POISONING COTTON WORMS.

As has been explained, the feeding habits of these worms are such that it is a very easy species to control by simply dusting an arsenical poison lightly over the top of the cotton plants. The discovery that this could be done is said to have been made in 1872 by an Alabamian living near Mobile. At any rate, the use of Paris green for this purpose began at about that time, and it was used quite extensively in 1873, which was such a disastrous year for this State. In 1879 agents of the United States Department of Agriculture working in Alabama made a series of tests of various poisons and established the superiority of Paris green among all the materials known at that time. Paris green remained the best material known until 1907, when powdered arsenate of lead was first produced for special experiments with it against the boll weevil. In 1911, therefore, occurred the first opportunity for comparing this new material with the more widely known Paris green for cotton worms.

Powdered arsenate of lead.—This is by far the best poison for the control of the cotton worm. There is a "paste" form made which can not be used except for spraying. The other form known as "powdered" arsenate of lead is a very fine white powder having about one-half the amount of arsenic in it that is in Paris green, and should therefore be used at least twice as strong as we use Paris green to secure the same killing power. It never burns, even if applied to foliage in heavy doses, and sticks to the leaves very well in spite of rains. It seems to be so very fine that it gets into the small depressions on the leaves and the water runs over it. We therefore advise a dose of 3 pounds of powdered arsenate of lead per acre for average cotton when this can be secured in place of Paris green. No flour or any other material is needed in this case. Closely woven flour-bag cloth or unbleached sheeting should be used with this very fine material. It is easier to apply this arsenate of lead evenly than it is Paris green and flour.

Paris green.—For nearly 40 years this has been the best poison known for the cotton worm, and for this reason is still in demand among those who have used it or who have not yet tried the arsenate of lead.

Other poisons.—No other poisons now on the market need be considered. Arsenite of zinc might have value, but has not yet been tested on cotton. London purple is certain to burn badly, and white arsenic is sure to kill every leaf it is put on. Do not waste time and opportunity fooling with untried or unreliable or fake remedies.

Comparisons.—It is a well-known fact that Paris green is very likely to burn cotton foliage in spots even where carefully distributed and is certain to do so where at all carelessly put out. Many planters know also that it has the effect of checking the setting of fruit when applied to young cotton even where burning of foliage is not apparent. This is a matter for very serious consideration. We can not advise the application of Paris green to any cotton until after the crop of bolls is well made and nearly mature, if it be possible to secure the arsenate of lead in its place.

Furthermore, it is well known that Paris green, even when applied with flour, is readily washed off the plants by rains and even by heavy dews, so that the effectiveness of an application may be entirely destroyed within 24 hours. In many places there is also a strong prejudice against Paris green because of the fact that it is likely to cause sores on the men and mules using it for any considerable length of time. In some cases in 1911 this resulted in the positive refusal of workmen to continue handling Paris green. The trouble on the plant, workmen, and animals is that Paris green contains four or five times as much water soluble arsenic as does the arsenate of lead, and this is the constituent that burns.

On the other hand, powdered arsenate of lead even when applied as heavily as 10 pounds or more of the undiluted poison to the acre does not burn foliage and does not check the setting of fruit. This material adheres to the foliage five times as long as does Paris green. It therefore gives the plants all the advantage of continuous protection and is economical to use because fewer applications are required. Many hundred thousand pounds of this material were used in 1911 without a single record of its causing sores on men or mules. Therefore, while costing slightly more per acre for the poison and requiring

the application of more powder to the acre than is the case with Paris green, the real saving in the crop and the safety with which it may be applied makes this material the best that we know for application, particularly to cotton before the crop is nearly matured, at which time Paris green could be used if already on hand. Never use white arsenic or London purple on cotton.

Paris-green treatment is cheaper than that with arsenate of lead if we consider only the first cost of the materials used in each application, but real economy is measured by the saving in crop obtained as compared with the total cost of protecting it to the end. On this basis it may be far more expensive than the lead for any one or all of several reasons. A heavy rain falling within 24 hours after the application will so wash Paris green from the plants that it may be almost wholly ineffective and the work must therefore be done over at once. That application was therefore entirely wasted. Again, if through its effect on the plant in checking fruiting, there results the throwing off or prevention of making of even one boll on every 10 stalks on the average, then it will cost more than the arsenate of lead treatment. The effect would surely be much greater than this.

Analysis, with quotation of price.—The large stocks of both Paris green and arsenate of lead in Alabama include the products of several different manufacturers. In all cases where considering the purchase of either poison the buyer should insist upon being given a statement of the guaranteed analysis of the poison, together with the quotation as to its cost, just as he would do with a fertilizer, like acid phosphate. In this way he can best determine where he can get the maximum of insect-killing value at the minimum cost. Arsenate of lead should contain from 23 to 33 per cent of arsenious oxide, and the cost may vary accordingly. Paris green should have 50 to 56 per cent arsenious oxide. In case of extreme shortage of poison it may be necessary to make use of what stock is available of what is known as "Paris-green residue," which is a low-grade product not ordinarily used as an insecticide. In many localities planters may combine their orders and secure the benefit of lower prices and freight rates. Neither poison loses strength and they may be kept for years if simply kept very dry.

INFORMATION ABOUT USING POISONS.

Arsenate of lead.—With powdered arsenate of lead we make it the general rule to apply at each application as many pounds per acre as the cotton is feet in height. These limits can be drawn in somewhat, as 2 pounds will be needed even on small cotton, and that 6 feet high could be fairly well protected with 4 or 5 pounds. The cost of the poison will probably average close to 25 cents per pound for 25 to 33 per cent powdered arsenate of lead. Multiply this by the number of pounds to be used per acre and add about 5 or 10 cents for the labor of application to get at the cost of treatment.

Paris green.—This material can not be applied with any assurance for the safety of the plant stronger than 1 to 1½ pounds per acre. With this we must use some 2 pounds of flour for every pound of Paris green to be applied. The poison will cost also about 25 cents per pound in small lots. To this add the cost of flour and labor.

Number of applications needed.—This depends on which poison you decide to use. With the arsenate of lead it was found in 1911

that one good dusting applied at the beginning of each "crop" of worms would give the cotton full protection from the entire generation. This material sticks in spite of dews and rains, so that it remains effective for the last as well as the first hatched worms in each generation. Experience has shown, however, that even with this a new application must be made at the beginning of each "crop" of worms. Three treatments with arsenate of lead may be expected to carry the crop through the worst part of even the most serious outbreaks. The stock of poison needed may be closely estimated and purchased at the beginning of the season.

With Paris green so much depends upon the state of the weather that it is simply impossible to tell with any certainty how many applications may be required. In 1911 fields were seen where three and four applications had been made for *one* "crop" of worms, and the plants were in bad shape then. It will not be safe to count on having to make less than five applications of this material, and even then the protection given the crop may be less complete and continuous than with the other poison.

When to apply poison.—Watch your cotton closely and frequently for the first signs of worm work. These usually occur in the low wet places where the cotton is rank. The cotton worm feeds on no plant but cotton and few other worms do a similar work in "ragging" the leaves or stripping the plants. The "first crop" of worms will usually appear in spots through the field and not attacking all parts uniformly. The worms should be poisoned at once whenever and wherever they are found to be "ragging" the tops of the plants. At the time of appearance of the "first crop" it will not pay usually to treat the whole field unless the worms are scattered through it. If the "first crop" appears in considerable numbers during the last of July or first of August, and if the season is rather wet and cotton rank and thrifty, then there is great likelihood of extensive damage from the "second crop" which may appear in from 10 to 15 days after the worms of the first crop spin up. Every preparation should be made in advance when such conditions occur so that the whole cotton crop may be treated without a single hour of avoidable delay. Have the dust poles and bags ready and the stock of poison on hand. Such preparation is essential to the best success in controlling these worms. One dollar expended in poisoning caterpillars during August may save from $10 to $50 loss in the crop. It pays to kill the worms early. (See Pl. III, figs. 1 and 2.)

Sources of poison supply.—These arsenical poisons are manufactured entirely outside of the cotton States. The addresses of manufacturers and wholesale dealers can be obtained from a local druggist or by writing to the State experiment station and quotations on large quantities thus gotten at bottom prices. Most buyers, however, will not prepare early enough to allow shipments from long distances to reach them in time to save their cotton. They depend upon reaching a nearby center of supply. In each of the larger cities of Alabama may be found one or more firms handling these poisons. They should advertise their stock during every outbreak of worms so that farmers may know where to get their poison with least delay.

Place your order early. You can not expect a dealer to assume all the responsibility and carry a stock large enough to cover all possible demands in his territory. Bankers, merchants, oil-mill men and

fertilizer men especially should make it certain that an adequate supply of poison can be had by their customers without delay and

PLATE III.—PROTECTING COTTON FOLIAGE.

Fig. 1, on left, foliage saved by poisoning; on right, cotton stripped by worms and crop cut 8 per cent. Fig. 2, very rank cotton protected through season by three dustings with arsenate of lead, yielding nearly 2 bales per acre. (Original.)

every assurance given the farmer that he can get this poison at very reasonable cost. Those who have already "advanced" on the crop should insist that their customers apply the poison for the protection of their common interests.

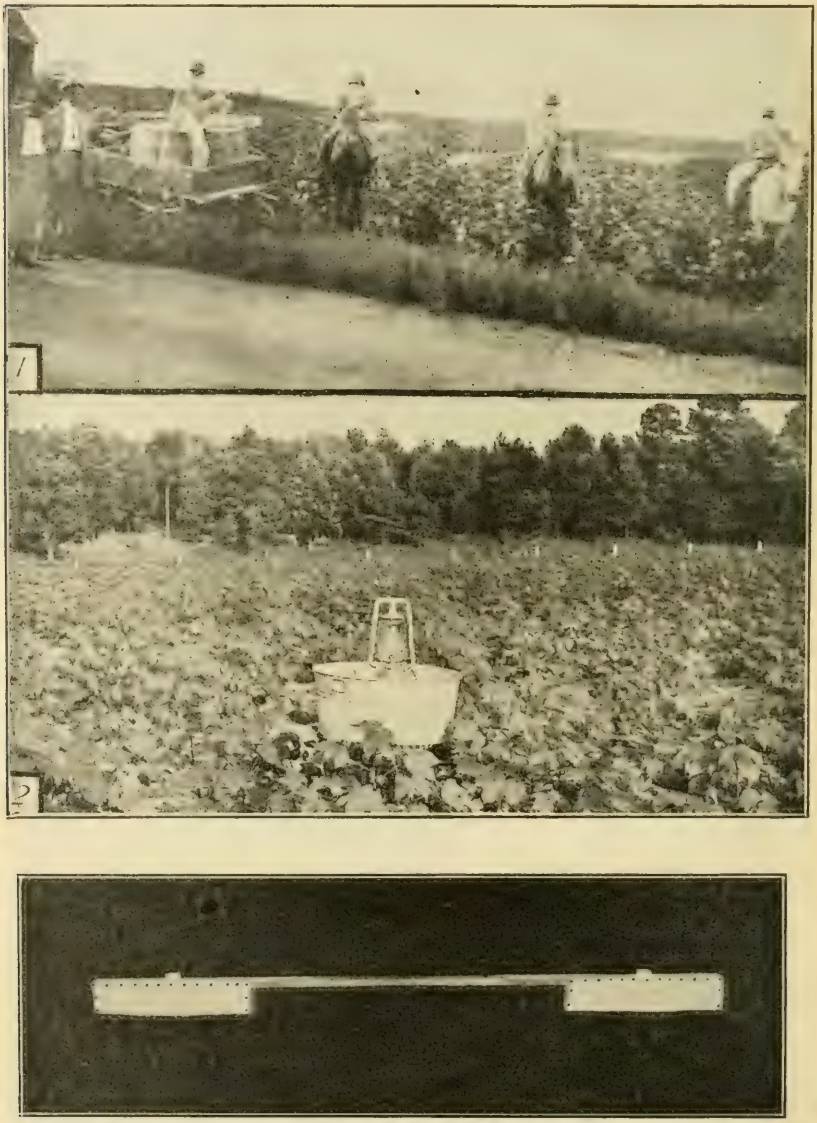

PLATE IV.—APPARATUS FOR DESTROYING WORMS.

Fig. 1, large scale work economically done; fig. 2, trap lantern utilizing washtub—a shallow pan is even better; fig. 3, dusting outfit of good type.

Methods of application.—Either of these poisons can be applied as a spray or a dust. Few cotton planters, however, have equipment for the spraying and that method of application requires slower work

than the dusting. Under the subject "Feeding habits" we have shown why a dust application is unusually simple and effective for the cotton worm and that is why we recommend the dust treatment.

THE DUSTING TREATMENT.

The simplest possible method for destroying cotton worms is to apply a dry poison like Paris green, or better, powdered arsenate of lead, dusted through bags carried at the ends of a pole or piece of narrow board, by a man riding a mule. This covers two rows at a time and 15 to 20 acres can be treated by one man in a day. On moonlight nights the work might probably be continued in cases of emergency. Somewhat less uniform but more rapid work can be done by making the board long enough to cover four rows, or better, three middles. Two bags should be used on each side, if the board is more than 10 feet long, to give better distribution of the dust. The spring in the longer boards makes it unnecessary to jar them. They may simply be held firmly on the front of the saddle and the mule ridden at a trot, leaving a cloud of dust behind. Where several men are working, they should ride abreast.

The outfit.—To make the dusting outfit, take a piece of 1 by 3 or 1 by 4 inch board and cut it about 18 inches longer than the distance at which the cotton rows are planted. Also cut four blocks off of the same board each about 4 inches long. In each end of the main board bore a 1-inch, or larger, hole, through which the poison can be poured into the finished bags. These holes may be closed with plugs or stoppers after the poison has been introduced. Nail the four blocks on the underside of the board, one at each end and the others about 16 inches from the ends. These blocks thus form the ends of the bags. The long board may be cut down in the middle to a width that is easy to hold in the hands and so as to remove unnecessary weight. (See Pl. IV, fig. 3.) For the bags to be used with arsenate of lead or Paris green with two parts of flour, such a cloth as unbleached domestic or sheeting answers well. This cloth will distribute about 3 pounds per acre. This should be folded over, stretched, and tacked closely to the side of the board, then around the blocks and to the board on the other side. The amount of poison distributed will depend upon the tightness of weave of the cloth and the jarring given the pole. If, with rather continuous jarring, not enough poison is being distributed, simply use more open cloth for the bags. Old flour bags may be used if on hand. Where it is desired to put out 5 or 6 pounds per acre, use double cheesecloth for the bags.

With Paris green a closer woven cloth may be needed and "8-ounce duck" may be used for light applications of the pure poison without any flour. It is desirable to use about 2 pounds of flour with each pound of Paris green to increase its sticking to the leaves, and flour bags or sheeting may then be used. Do not try to use old "oat sacks" and think that the work can be done economically.

Suggestions regarding applications.—The best air condition for applying a dust is found when it is still. The worms feed principally at night and in the early morning before they have difficulty in getting enough food. After that they may feed during bright days and are always more generally active during cloudy days. Dust poisons applied toward evening are therefore likely to be on the plant in

their maximum strength while the worms are feeding most actively. Dew forming on the poison helps to fix it in place, but very heavy dews that drip from the plants may wash off a large part of the Paris green within a short time even without rains. When dusting while dew is on it is very important to avoid touching the dust bags to the plants, since if the cloth becomes wet the dust can not pass through it. Never attempt poisoning during or just before a rain with Paris green. Arsenate of lead can be put on with assurance that it will stay if it only has time to once dry on the leaves. There is a much greater safe-working margin with it than with Paris green in the dosage that can be safely used, the length of time that it can be used before the worms will get to it, and the sureness of the protection obtainable in showery weather.

Keeping track of weight.—A spring balance weighing up to 20 pounds is a convenient help in keeping close track of the amount of poison being put out. Weigh the whole outfit, pole, bag, and poison, after the poison has been put in and it is ready for the rider. After half an acre (an acre is 70 by 70 yards) or any known area is covered weigh again. The difference in weight shows just exactly how much poison has been put out on that area, and if too much is gone for the rate desired, either use heavier cloth for the bags, add another covering of thin cloth, or try lighter jarring. If Paris green is being used the proportion of flour to poison may be increased. If too little poison is going out, jar more heavily or use a lighter weight or more open cloth. This means economical treatment.

IS THERE DANGER IN USING POISONS?

This is one of the questions most commonly asked by those who have never yet used any. Fortunately the danger is far more imaginary than real. Both fear and danger in the use of poisons for the cotton worm or other insects arise almost entirely from ignorance as to their nature and effects. Only when very carelessly handled is there any real danger in using either Paris green or powdered arsenate of lead. Of course, both are strong stomach poisons, and their value in protecting cotton from the worms lies in this fact. They are not at all likely to produce any serious effects unless taken into the stomach of man or beast in very appreciable quantities. There is no real danger from getting either on the skin. It is true, however, that Paris green is liable to cause rather bad sores on men and mules where they are working with it constantly for several days in succession. This is due to the same quality of Paris green that makes it bad to use on thrifty growing cotton. It usually contains about 3 per cent of arsenic in a form that is soluble in water or in perspiration. This causes the burning of foliage and also the sores on men and mules. This, however, never happens with the arsenate of lead. The only real danger to stock lies in allowing animals to get into freshly poisoned fields and to feed therein for several hours at a time. One case is known to me where cotton was planted on a steep slope nearly encircling a small pool into which it drained. No stream flowed through or from this pool, but it was used as a water hole for some farm stock. Very soon after the cotton was very heavily poisoned with Paris green a heavy shower washed it from the plants and down the steep hillside into the water hole, where it was held and concentrated to such an extent that

some of the animals drinking there were poisoned. But these conditions would not occur again in many thousands of cases. Every report of the killing of men and of mules that could be investigated in 1911, with only one exception, were found to be mere "rumors" or mistakes. In that case an animal broke into a freshly poisoned field and fed all night, so that it got a fatal dose. There is very rarely need to muzzle mules to protect them during an application. There is no chance whatever of "poisoning the soil," and no danger in letting stock feed, even where arsenate of lead has been used, after a month's time. There is no danger to stock drinking from running streams passing through treated fields nor to cotton pickers at picking time. Poultry may possibly be killed if allowed to feed extensively on worms dying from poison. A few simple, sensible precautions should, however, be observed.

Precautions.—Keep all poison so marked in a plain manner and store it in a dry place out of the reach of children and farm animals. Fill cuts or scratches with vaseline or some grease and tie a cloth over it or wear gloves. Work toward the wind if it is blowing across the field. Tie a cloth or handkerchief over the mouth and nose if obliged to ride with the cloud of dust to any great extent. Clear the throat occasionally and spit out the accumulation instead of swallowing it. If using Paris green, brush off or wash off mules and men after the day's work. If the work extends over several days, change men and mules to give each a rest, for it is hard work when followed constantly. Shut up poultry for two or three days when cotton, where they might spend most of their time, has just been treated. In case of accidental poisoning, produce vomiting as quickly as possible by running a finger down in the throat. Hot milk or mustard water will usually start it. Then give milk, raw whites of eggs, or magnesia (magnesium oxide), a rounding teaspoonful in a glass of milk. Get a doctor at once.

LIGHT TRAPS.

Cotton worm moths are readily attracted to lights and may be trapped in large numbers, thus preventing many worms, but at best this can not be considered as a substitute for poisoning. It will be helpful to test the emergence of the moths in this way and thus to know just when to begin the applications of the arsenate of lead.

A lantern or light trap (see Pl. IV, fig. 2) may be easily and cheaply made, as follows: Arrange in some way by using a box, barrel, or stake with a board on top, to raise the trap a foot or two above the tops of the cotton plants. Place on this a shallow pan or a tub containing an inch of water, with just enough kerosene or coal oil to form a film over its surface to kill the insects that may fall into it. In the middle of the pan set an ordinary lantern. Let this burn through the night to attract the moths which may come from some little distance to it. No one knows how far this will attract them. Doubtless much depends upon the brightness of the light or the darkness of the night. There is no danger of drawing moths to the field without catching them and thus decreasing their injuriousness. The whole effect is like that of pouring water. It flows only as you lower the surface at some point. Such lights will attract

many moths and other insects beside the cotton moth, and the oil will so change the appearance of those caught that one must know the moth well by size, shape, and wing markings to tell them. Bonfires do less good than lanterns, as the heat repels the moths before they get singed. Flying against the lantern, they simply drop into the oil and water.

DOES IT PAY TO FIGHT COTTON WORMS?

It seems almost ridiculous to ask such a question, and yet from the fact that a very large majority of cotton planters will sit quietly by and see their crop eaten up and their season's work largely destroyed, without being willing to spend from $1 to $3 per acre to save it, it appears that the average man does not yet believe that it will really pay him to make this fight. Let us therefore consider the question a fair one and figure out the answer.

On the average field there are at least 5,000 cotton plants, and with most varieties it does not take over 80 bolls to make a pound of seed cotton. One boll to the plant therefore means about 60 pounds of seed cotton, containing about 20 pounds of lint and 40 pounds of seed. At the price of the 1911–12 season this lint is therefore worth over $2 and the seed about 50 cents more, giving us a total value of over $2.50 for each boll per stalk per acre. Now, an average application of arsenate of lead will cost about 75 cents for the poison and not over 15 cents per acre for its application, a total of 90 cents per acre for each application, which is only about one-third of the minimum saving in the crop if by the treatment we insure the opening of but one more boll per stalk than would have opened otherwise. One boll per stalk will pay for the three complete poisonings, which is the maximum that may be required for the three "crops of worms" which may appear before the cotton is ready to open. Will it pay? Who does not believe that by saving the foliage on his cotton from the worms he can save more than one boll per stalk? In 1911 in cotton fields thought to be so nearly mature that the worms would do them no harm whatever, few escaped without the loss of two or three bolls per stalk. In 1911 the average damage throughout Alabama could not have been less than 10 per cent of the crop gathered, or somewhere between 150,000 and 200,000 bales for the State. The cotton-worm tax here last year was probably not less than $10,000,000, and would have been far more but for the fortunate fact that in that year between 90 and 95 per cent of our crop was "made" before the 1st of August. Very little increase took place after that time. Our crop of 1912 averages all of three weeks later than that of 1911. The possibility of injury to the 1912 crop is therefore correspondingly greater.

COTTON WORM VERSUS BOLL WEEVIL.

We have here a peculiar case of natural conflict between two exclusive cotton pests attacking normally entirely different parts of the plants. The boll weevil depends absolutely upon the presence of squares and bolls for opportunity to reproduce. When the fields are stripped clean by the cotton worm nature demonstrates to us on a large scale the value of a practically complete destruction of cotton at an early date as a measure of control for the boll weevil. In seasons

of general cotton worm occurrence the late developed weevils are so reduced in numbers that the cotton crop of the following year is usually but lightly infested until an unusually late date the following year, with consequent advantage to the crop. One cotton pest—the cotton worm—thus serves to control the other—the boll weevil. The cotton worm may be considered as a friend by the planter in weevil territory when it occurs after the bolls are all practically full-grown, because of this effect on the weevil. Whenever the two pests occur together before cotton has reached this stage poison should be used for the cotton worm, as only thereby can the largest possible crop be secured. As a general rule in Alabama cotton worms should be poisoned everywhere until the 10th to 15th of September. Cotton should be picked out as promptly as possible after it opens, and then the planter may complete, by deeply plowing under or by plowing out and burning the stalks, the control of the boll weevil that may be begun by the cotton worm.

COTTON WORM APPEARANCE, 1912.

The first appearance of cotton worms in the United States this season was, as usual, in the southern extremity of Texas. This was noticed about the 1st of May. The third generation in that section became mature about the middle of July.

During the first week in June a number of moths were taken at lights in Mobile, Ala. These may possibly have flown across the water from some of the West Indian Islands. Cotton worms were found in, or reliable reports of their occurrence received from, Alabama counties on the following dates: Mobile, June 6; Conecuh, June 21; Autauga, July 12; Pike, July 18; Geneva, Covington, and Montgomery, July 19; Butler, July 22; Perry, July 24, etc.

On July 24 Prof. R. W. Harned, of Mississippi, reported cotton worms as occurring in Lowndes, Monroe, Oktibbeha, and Noxubee Counties, in that State. We are now having in coincidence the conditions that have occurred whenever there have been general outbreaks of the cotton worm, and there is little likelihood that we shall escape this year. At the present time the prospect is for fully as extensive an outbreak, and for even more serious injury to the crop than occurred in 1911. We can only hope that by last year's experience we may be more promptly and fully prepared, so that we may make the fight this year more general, more economical, and more effective than any such fight has ever been before. It will pay to poison even as the bolls are opening to keep the lint free from trash and staining, which is frequently a serious matter, as suggested in the view in Plate II, fig. 3.

It has been so clearly and abundantly proven that cotton can be completely protected from this pest at very low cost compared with the loss that is bound to be sustained if the cotton worms are allowed to strip the fields at any time before the crop is fully matured, that no one should hesitate to undertake to fight against the cotton worm.

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